Effects of Multiple Sprint Test on Average Speed and Exercise Heart Rate in Amateur Soccer Players

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Abstract

The purpose of this study is to investigate the effects of multiple sprints on average speed and exercise heart rate of U18 female and U18 male amateur soccer players. In this study, totally 42 amateur soccer players including U18 (n= 21) and U18 (n=21) players performed 7 repetitive sprints of 34.2 meters with a 25 seconds jog of 50 meters distance. During exercise and recovery period, heart rate per minute was recorded by Polar Heart Rate Telemetry. In statistical analyzes, t-tests were used in two groups comparisons, while the effects of other variables on average speed and cardiovascular parameters were determined by two way analyzes of variance.

Results of this study, U18 male players' average speed of 5.14 m/ sec is higher than the U18 female players' average speed of 4.62 m/sec. The physical characteristics of U18 male and U18 female amateur soccer players were different in favors of the U18 male players, and that gender was significantly effective on the average speed rather than the number of sprints. Heart rate per minute has continually increased in different characteristics at the start, finish and recovery periods of the sprints until the finish of the seventh sprint in both amateur U18 male and U18 female. It found increase in the Sprint time were as follows; U18 female 0.40 sec and U18 male 0.20 second. Decrease in the average speed was U18 female 0.28 sec., and U18 male 0.15 second.

Conclusion, in multiple speed tests, maximum and average speed of the U18 amateur female and male soccer players, the decrease rate in their speed and their cardiovascular responses show differences. In U18 Amateur, males seem to be faster and have the ability of keeping speed at a high level, and the ability of intensity and recovery in maximal level in a short time than the females.   In the Bangsbo test, the recovery time in men should be less than 25 seconds.

Keywords: soccer, average speed and cardiovascular response

1. Introduction

Soccer is an intermittent sport which requires players to undertake many technical, physical, and tactical actions. Previous research suggests that agility, power development, repeated sprint ability and endurance capability represent determinant factors for success in soccer (Chtara et al., 2017). Even perception of colors affects success (İmamoğlu, 2010; İmamoğlu, 2011). Soccer is described as a multiple-sprint sport, reflecting the need for players to repeatedly sprint throughout the duration of a match. It is thought that sprint efforts are associated with crucial moments of match play, and, as a result, the ability to repeatedly sprint represents an important performance characteristic. To measure this performance characteristic, tests of repeated-sprint ability have become popular. In the literature repeated-sprint ability has been defined as the ability to perform repeated short-duration sprints over a brief period of time, with tests of repeated-sprint ability reflecting an intense period of play during a match. Tests of repeated-sprint ability have been shown to distinguish between both adult and youth players of varying standards; however, the link with performance in a match is less clear (Reilly, 1997; Spencer et al.,, 2004; Abrantes et al., 2004). Abrantes et al., (2004) examined to football players' sprint test performance across different ages and levels of competition and reported that the main effect of sprint trial was also statistically significant. According to statistical analysis, mean sprint times from the first trial were significantly slower than mean sprint times from the second, third and fourth trial. Results from the fifth, sixth and seventh trials were slower. Soccer is a complex sport requiring the repetition of many diverse activities (e.g., jogging, sprinting and jumping) over 90 min (Bangsbo et al., 1991; Mohr et al., 2003; Wither et al., 1982). Soccer players are required to repeatedly produce maximal or near maximal sprints of short duration (1–7s) with brief recovery periods

(Bangsbo et al, 1991; Wither et al., 1982, 43). Therefore, the ability to repeat multiple sprints at high speed (i.e., RSA) is important for soccer physical performance (Bangsbo, 1997; Wragg et al., 2000).

In today's soccer, becoming a matter of primary importance of physical aspects and increasing of social popularity from day to day caused of a necessity. This necessity is that improving physical aspects of soccer players and maintaining these aspects at maximum level (Luxbacher, 1986). In general, during a 90-min soccer match, 80%-90% constitutes to moderate to low intensity whilst the remaining 10%-20% is high intensity running (Bloomfield et al., 2007; Rienzi et al., 2000; İmamoğlu and Kılcıgil, 2007). Several authors have observed players at the top of their national league (Bangsbo et al., 1991; Bangsbo, 1994). These studies have suggested that the amount of high-intensity exercise is a valid measure of physical performance in soccer. One of the most important parts of today's soccer players' performance is that they are able to succeed at high speed short-distance runs of straight or different directions as much as possible from the beginning to the end of the game. The ability of gaining speed in short distance and time is important while possessing ball from the opponents or while stopping them from maintaining the ball (Ekblom, 1994). It is stated that, during a soccer game, many of the sprints done with maximum power are generally straight and the sprint distances change between 5-50 meters (Yamak and İmamoğlu, 219). On the other hand, Withers et al., (1982) state that during a game, maximal sprint distance changes between 20 and 30 meters, players do approximately 100 speed sprints, they reach maximal speed after 30 meters, they keep their speed between the 30 and 60 meters of the sprint and their speed decreases after that. Ekblom (1994) claims that during a soccer game average sprint distance is 15 meters and maximum sprint distance is 40 meters. The same researcher states that acceleration in sprints with high starts from a stable position up to 30 meters and also maximal running speed in sprints between 30 and 50 meters which start with gaining speed can be measured.

Based on Nikolaidis et al., (2016) findings, it is evident that coaches should increase their focus on the development of the sprint ability in football players. When the running distance is divided by the running time, average running speed can be measured in m/sec (Ekbolm, 1994). Sprinting has been suggested as the most frequent action performed before a goal Haugen et al., 2014). Players in the German national football team were found to perform ~17 sprints per game (Schimpchen et al., 2015). It has been reported that although sprinting and high intensity actions represent only 10 to 15% of covered running distance, they are extremely decisive for the outcome of the game in both elite male and female soccer (Gabbett and Mulvey, 2008).

Therefore, the aim of this study is to determine the effects of repetitive sprints on average speed and exercise heart rate of male and female young amateur soccer players.

2. Methods

2.1 The Study Group and Design

In the Sakarya Gymnasium in January 2015, 42 amateur soccer players, 21 of whom were male (U18) and 21 of whom were female (U18), participated in this study voluntarily as subjects. Body weights were measured with an accurate weighing machine (0.1 kg) and heights were measured with the help of a metal bar on this weighing machine (0.1 mm accurate). All of the speed measurements were done in the afternoon with Prosport TMR ESC 2100 model multi-doored telemetric chronometers. From high start stable position the subjects were made to run 7 repetitive maximum effort sprints of 34,2 meters and also to take multiple speed tests with 25 seconds 50 meters run in-between the sprints (Bangsbo, 1994).

At the very beginning of the start, the footballer's front toe tips were placed on the beginning of the running distance and thus the subjects were made to get a high start. Average run speed was measured in m/sec by dividing the running distance by the running time. The percentage of the difference between the mean of the first two runs and the mean of the last two runs was taken as the ratio of fatigue. Moreover, the best running time and the mean time of 7 runs were calculated. The number of heart beats in the course of exercise and recovery were determined by Polar Heart Rate Telemeter.

2.2 Statistics

Descriptive statistics about the Footballers' running times and average speed in different sprints were calculated. T-test was used in comparing the physical characteristics of the U18 amateur male and female soccer players. Two-way variance analyses were used to determine the effects of 7 different speed runs and gender on the Footballers' average speed and the number of heart beats during exercises the effects of the different phases of recovery and gender on the number of heart beats per minute, systolic and diastolic blood pressure.

3. Results

Table 1. Comparison of the male and female players' physical characteristics

Variants	Group	N	X ± SD.	Min-Max	t-value
Height (cm)	U18 Female	21	162.11±4.95	150.9-169.0	-8.12**
	U18 Male	21	175.23±4.74	166.5-183.0	
Weight (kg)	U18 Female	21	60.21±7.16	44.4-69.6	-6.51**
	U18 Male	21	72.35±7.52	59.2-87.0	
Age (years)	U18 Female	21	17.30±3.92	15.0-18.0	1.02
	U18 Male	21	17.37±2.06	15.0-18.0	

**p < 0,01

Table 2. Running time and average speed values of the male and the female players

	34.2 meters Running Time (sec)				Average Running Speed(meters/sec)			
	U18 Male		U18 Female		U18 Male		U18 Female	
Sprint Number	X ± SD.	Min-Max	X ± SD.	Min-Max	X ± SD.	Min-Max	X ± SD.	Min-Max
1	6.57±0.58	5.21-7.28	7.18±0.72*	5.59-8.09	5.21±0.53	4.72-6.59	4.76±0.52*	4.24-6.16
2	6.51±0.71*	4.98-7.69	7.25±0.59	5.92-8.07	5.25±0.65*	4.47-6.91	4.77±0.40	4.26-5.89
3	6.65±0.69	4.98-7.43	7.41±0.48	6.28-8.05	5.14±0.68	4.60-6.90	4.79±0.31	4.25-5.53
4	6.67±0.70	5.03-7.53	7.47±0.57	6.38-8.39	5.13±0.67	4.58-6.81	4.58±0.33	4.11-5.28
5	6.68±0.73	4.96-7.87	7.58±0.53	6.34-8.39	5.12±0.69	4.36-6.93	4.51±0.31	4.09-5.31
6	6.70±0.72	5.17-7.85	7.60±0.58	6.68-8.39	5.10±0.66	4.37-6.63	4.50±0.29	4.08-4.97
7	6.77±0.63	5.09-7.51	7.63±0.49	7.03-8.18	5.05±0.55	4.56-6.77	4.48±0.23	4.18-4.89
Total	6.65±0.68	4.96-7.87	7.41±0.54	5.59-8.39	5.14±0.62	4.36-6.93	4.62±0.37	4.08-6.16

*Best running time or average speed.

Table 3. The effects of gender and sprint number on running time and average speed

Dependent Variable	Factors	Total Square	df	Average Square	F
Running Time (sec)	United	47.28	7	6.74	16.35**
	Gender	44.30	1	44.19	112.24**
	Sprint Number	3.09	6	0.51	1.22
Average Speed (m/sec)	United	26.45	7	2.05	7.03**
	Gender	24.23	1	24.20	99.46**
	Sprint Number	1.60	6	0.23	1.01

**p<0.01

Table 4. The Descriptive Statistics of the Male and the Female Players' Heart Beat Rates in the Start, Finish of the Sprints and in the Last Quarter of the Recovery Run

Variables	Group	Mean	S. Deviation	Min.	Max.
Start	U18 Male	176.62	21.50	89.00	197.00
	U18 Female	167.46	21.16	93.00	192.00
Finish	U18 Male	183.28	19.15	105.00	201.00
	U18 Female	175.89	19.42	109.00	211.00
The Last Quarter of the Recovery	U18 Male	185.91	8.95	143.00	198.00
	U18 Female	178.62	12.35	152.00	194.00

Table 5. The effects of gender and sprint number on the number of heart beats in the different phases of the speed runs

Dependent Variable	Factors	Total Square	df	Average Square	F
Start	United	102140.290	7	14461.90	77.53**
	Gender	6120.945	1	6101.95	32.48**
	Sprint Number	95239.345	6	15846.56	85.37**
Finish	United	49266.676	7	7035.24	47.66**
	Gender	7892.861	1	7882.86	52.54**
	Sprint Number	41493.815	6	6878.97	45.44**
The Last Quarter of the Recovery	United	14521.668	7	2055.95	28.98**
	Gender	6325.147	1	6315.15	72.16**
	Sprint Number	8027.521	6	1346.10	18.36**

**p<0.01

Table 7. The Effects of the first and last two sprints means and Gender on the Male and the Female Players' Sprint Time and Average Speed

Dependent Variable	Factors	Total Square	df	Mean Square	F
Sprint Time (sec)	United	6656.97	1	6624.93	17982.1**
	The first and last two sprints Means	2.329	1	2.32	7.2*
	Gender	22.370	1	22.35	62.4**
Average Speed (m/sec)	United	3347.49	1	3326.52	13983.1**
	The first and last two sprints Means	1.25	1	1.14	5.1*
	Gender	12.24	1	12.13	52.7**

**$p < 0.01$

Table 8. Relating the Heart Beat Rates of the Male and the Female Players at Different Times during the Recovery Phase

Variables	Recovery Period	U18 Male		U18 Female	
		X ±SD.	Min-Max	X ±SD.	Min-Max
Heart Beat Rate (beat/min)	1st Minute	110.92±11.92	89.0-128.0	153.18±14.80	121.0-172.0
	3rd Minute	104.00±10.24	79.0-124.0	113.15±12.91	86.0-142.0
	5th Minute	100.11±10.97	72.0-122.0	106.33±16.15	74.0-136.0

Table 9. The Effects of Gender and Resting Period on the Heart Beat Rate during Recovery Phase

Dependent Variable	Factors	Total Square	df	Mean Square	F
Heart Beat Rate (beat/min)	United	26880.62	3	8937.20	51.56**
	Gender	12159.65	1	12158.65	67.30**
	Resting Period	14821.96	2	7361.48	40.69**

**$p < 0.01$

4. Discussion

In this study, Amateur U18 male soccer players' average age level was 17.30 years (n=21), average height level was 175.23 cm, average weight was 72.35 kg and amateur U18 female soccer players' average age level was 17.37 years (n=21), average height level was 162.11 cm, average weight was 60.21 kg (Table 1). Between U18 male and U18 female soccer 0.01 level was differences height and weight meaningful. Between of Age was no differences (p>0.05).

Bangsbo's (1994) 7.10 seconds average running time with the range of 6.83-7.31 seconds for 11 top-level Denmark soccer players is higher than the 6.58 seconds value for the males and lower than the 7.45 seconds average of the females in our study. Imamoglu et al., (2012) in study, the sprint averages were between 5.98 sec - 7.78 sec. It has also been observed that players at a higher standard of competition perform significantly more high-intensity running than those at a lower standard (Bangsbo et al., 1991). Özdemir et al., (2014) study, results indicated that in repeated sprint ability, best sprint time and total sprint time improved with age while no improvement was obtained in performance decrement. İmamoğlu et al., (2013) in one study, while no significant difference was observed between professional and amateur soccer players in terms of their speed performance. In this study, as for the average running time connected with the sprint number, neither U18 males nor U18 females have a tendency for continuous increase. While the U18 male players' average running time in the first, 3th, 5th and 7th sprints are respectively 6.57, 6.65,6.58 and 6.77 seconds; the same values are 7.18,7.41, 7.58 and 7.63 seconds for the U18 female players. Similarly, while the average speed values of the first, 3th, 5th and 7th sprints are respectively 5.21, 5.25, 5.12 and 5.05 m/sec for the U18 males, they are respectively 4.76, 4.79, 4.51 and 4.48 m/sec for the U18 female. In total, the U18 male players' average speed of 5.14 m/ sec is higher than the U18 female players' average speed of 4.62 m/sec. For the U18 male, average speed range between 4.36-6.93 m/sec, and between 4.09-6.16 m/sec for the U18 female (Table 2). These results show that U18 amateur footballers of our study are faster than the U18 amateur females. In this study, the running time and accordingly average speed changed for the young amateur male and female players, no change was seen connected with the number of speed run (Table 3).

Yamak and İmamoğlu (2019)in a study, in between U16 and U 18 category soccer players, it is found out a meaningful difference on the average speed in the first two sprints and the average speed in the last 2 sprints (p<0,001). İmamoğlu et al., (2018) in a study, run time, the average of 1st and 2nd sprint (the best run average) is 3,61 second, the average of 9th and 10th sprint (the best last average) is 4,24 sn. There were a statistically meaningful difference between the two average

(p<.01). In this study, Male soccer players are the best 2nd runner and female soccer players are the best 1st runner. The running speed has generally decreased gradually (5, 6, and 7th sprint). This difference between females and males can be explained with a partial renewal of phosphate deposits in males, and poor renewal in females during 25 seconds 50 meters jogs, and with a decrease in the force of pushing the ground because the females have less muscle mass when compared to the males and also different anthropometric structure.

İmamoğlu et al., (2012) in study, found the end of the sprints heart beat frequencies were found as Erzurum sports 172.57 beats/min, Samsun Power 185.95 beats/min, 1st amateur 181,93 beats/min, 2nd amateur 178.81 beats/min and students 183.72 beats/minute. After the 5 minute relaxation following the sprints the heartbeat frequencies decreased by 98,30 beats/min for Erzurumspor, 113.34 beats/min for Samsun power, 97.56 beats/min for 1st amateur, 101.01 beats/min for 2nd amateur and 122.89 beats/min for the students. Mc Ardle et al. (1967) in their study on male subjects found that the maximum number of heart beats for 60 yards (55 meters) and 200 meters were respectively 177 and 191 beat/min for the contender athletes, the same values were reported as 162 and 168 beat/min for the subjects with no training beforehand. On the other hand, the average maximal number of heart beats were reported as 179 beats/ min for the South Australian soccer players (Withers et al., 1982), 176 beats/ min for the West Germany National Team soccer players (Nowacki et al., 1988) and 198 beat/ min for the English League soccer players (Reilly, 1997). All of these values are similar to the norms of normal population (Ekblom, 1994). I this study, in the start and finish of the sprint and in the last quarter of the recovery average heart beat rates are respectively 176.62, 183.28 and 185.91 beat/min for the males, the same values are respectively 167.46, 175.89 and 178.62 beats/min for the females (table 4). During the start, finish and last quarter of the recovery sprint which are accepted as the different parts of speed runs, between amateur U18 males and U18 amateur females the number of heart beats per minute changes significantly (p<0.01) in-between the sprints. These values show that the cardiovascular intensity increases to the maximal level with a great speed in the multiple sprint test (table 5). The average values of U18 Males soccer in this study are similar to those of the in other studies and the average values of the subjects with no training beforehand are similar to those of the female players in our study. Cardiovascular responses are worse in female soccer players than male soccer players.

Fatigue or impaired performance in soccer occurs during various phases in a game, and different physiological mechanisms appear to operate in different periods of a game (Mohr et al., 2005). In Bangsbo's study, the 0.64 seconds mean fatigue index with the range of 0.15-0.92 seconds for the 11 top-level Denmark soccer players seems to be higher than the means of 0.10 and 0.17 seconds reported respectively for the male and the female in our study. Imamoğlu et al, (2012) in study, found that fatigue rates were between 0.27- 0.72 seconds. In this study, found increase in the Sprint time were as follows; U18 female 0.40 sec and U18 male 0.20 second. Decrease in the average speed was U18 female 0.28 sec., and U18 male 0.15 second (Table 6).

Five minutes after exertion , if the athlete's heart beats number is under 115 in a minute, his performance is good; if it is under 105 per minute, his performance is very good; and if it is under 100 beats per minute, this shows the athlete's state of high performance trained (Zint and Eisenhut, 1994). In this study, the difference is that male footballer's heart rates fell less than that female footballers. The reason of this case may be related to the difference of condition and physical exertion in the tests. For the time for pulse to return to the normal after efforts depends on the workload during the exercise and the person's condition level. Good-conditioned people's pulse returns to the normal faster following the exercise. Balsom et al. (1992) observed that performance in a 30-m sprint could be maintained when subjects have a recovery period of 120 s between each sprint, but a marked decrease was found when the recovery time was 30 s. This means that in order to evaluate an athlete's ability to recover from intense exercise the rest period between 30-m sprints should be 30 s or shorter. In the light of these findings, by evaluating different sides of the speed performances of the U18 amateur male and the U18 amateur female footballers training content, intensity and capacity should be determined.

While the multiple sprint test used in this study developed by Bangsbo (1994) seems to be suitable for the females in the occurrence of fatigue as a result of the repetition of speed runs, it is not suitable for the U18 males as it causes early recovery and late fatigue. For the U18 males, shorter distance recovery runs should be preferred between the sprints.

In this study, the 110.92 beat /min number of heart beats in the first minute decreased to 100.11 beat/ min at the fifth minute for the U18 males and the 153.18 beat/ min decreased to 106.33 for the females. At the very end of the multiple tests, during recovery, heart beat numbers per minute change significantly depending on the gender and relaxation time (table 9). These values show that the male players have a quicker recovery ability than the female players. Gender difference can be a result of the males' having max VO2's greater than the female in the rate of 5%-30%, and having lower body fat percentage than the female (McArdle et al., 1981). In this study, the difference is that U18 male footballer's heart rates fell less than that U 18 female footballers. The reason of this case may be related to the difference of condition and physical exertion in the tests. For the time for pulse to return to the normal after efforts depends on the workload during the exercise and the person's condition level. Good-conditioned people's pulse returns to the normal faster following the exercise. Various factors such as age, gender, body posture and person's condition level have an

impact on the respond which circulatory system gives to the muscle exercise (Yamak and Imamoğlu, 2019). After exercising, recovery in men is very fast in the first one minute and it gets slower in the following minutes. The fast decreasing has lasted about the first 3 minutes and it decreases slowly between 3rd and 5th minutes.

In conclusion, in multiple speed tests, maximum and average speed of the U18 amateur female and male soccer players, the decrease rate in their speed and their cardiovascular responses show differences. In U18 Amateur, males seem to be faster and have the ability of keeping speed at a high level, and the ability of intensity and recovery in maximal level in a short time than the females. Every category, in order to make an accurate determination of the quality and intensity of speed studies, photocell chronometers and wireless heart beat measurement devices should be used. In the Bangsbo test, the recovery time in men should be less than 25 seconds.

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